

RESOLUTION COM5-17 (WRC-97)

**CRITERIA AND METHODOLOGIES FOR SHARING BETWEEN THE
FIXED-SATELLITE SERVICE AND OTHER SERVICES WITH
ALLOCATIONS IN THE BAND 40.5 - 42.5 GHz**

The World Radiocommunication Conference (Geneva, 1997),

considering

- a) that this Conference has added a primary allocation to the fixed-satellite (space-to-Earth) service in Regions 2 and 3 and in certain countries in Region 1 and to the fixed service in the band 40.5 - 42.5 GHz;
- b) that these allocations will provide flexibility to those administrations that seek to implement systems in the bands between 36 and 50 GHz;
- c) that space service networks (fixed-satellite service and broadcasting-satellite service) will share the band 40.5 - 42.5 GHz on a primary basis with the fixed and broadcasting services;
- d) that Section 7.5 of the Report of the Conference Preparatory Meeting to this Conference recognized that sharing of spectrum in frequency bands above 30 GHz between the fixed service and one or more other services could result in service impairments, and that there may be utility in further study of the feasibility of co-frequency sharing between the fixed service and other services with allocations in these bands;
- e) that it may be useful to consider the identification of this spectrum range for high-density fixed service applications;
- f) that given *considerings* a) to e), it would be useful to conduct such studies in the band 40.5 - 42.5 GHz;
- g) that the new co-primary allocations to the fixed-satellite service and fixed service referred to in *considering* a) above are in the band adjacent to the band 42.5 - 43.5 GHz, which is the subject of an ITU-R study programme under Resolution COM5-16 (WRC-97);
- h) that there is a need to establish sharing criteria, including power flux-density limits, to facilitate the co-existence of the space and terrestrial services with allocations in the band 40.5 - 42.5 GHz,

invites ITU-R

- 1 to undertake, as a matter of urgency, studies of appropriate criteria and methodologies for sharing, including power flux-density limits, between the fixed-satellite service and the other services with allocations in the band 40.5 - 42.5 GHz;
- 2 to report on the results of these studies to the CPM of WRC-99,

urges administrations

to participate actively in the aforementioned studies by submitting contributions to ITU-R,

requests

WRC-99 to take appropriate action based on the results of these studies.

RESOLUTION COM5-18 (WRC-97)

**USE OF NON-GEOSTATIONARY SYSTEMS IN THE FIXED-SATELLITE
SERVICE IN CERTAIN FREQUENCY BANDS**

The World Radiocommunication Conference (Geneva, 1997),

considering

- a) that the International Telecommunication Union has, among its purposes, "to promote the extension of the benefit of the new telecommunication technologies to all the world's inhabitants" (No. 6 of the Constitution of the International Telecommunication Union (Geneva, 1992));
- b) that it is desirable, in this respect, to promote systems capable of providing universal service;
- c) that new telecommunication services need advanced and reliable networks permitting high-capacity communications;
- d) the need to encourage the development and implementation of new technologies;
- e) that systems based on the use of new technologies associated with both geostationary (GSO) and non-geostationary (non-GSO) satellite constellations are capable of providing the most isolated regions of the world with high-capacity and low-cost means of communication;
- f) that there should be equitable access to the radio-frequency spectrum and orbital resources in a mutually acceptable manner that allows for new entrants in the provision of services;
- g) that all Members of the Union would benefit from the implementation of proposed systems in the allocated spectrum and from avoidance of monopolization or exclusive use of an allocation by a single system;
- h) that the operation of such systems requires a suitable amount of spectrum in appropriate frequency bands;
- i) that decisions on this matter should permit the operation of as many systems as possible;
- j) that, in spite of the urgency attached to the development of such systems, technical, operational and regulatory issues should be studied in order to achieve the most efficient use of the spectrum that may be available for these systems;
- k) that there is a need for the provision of services on a competitive basis between GSO/FSS and non-GSO/FSS as well as between non-GSO/FSS and non-GSO/FSS;

- l) that the Radio Regulations must be sufficiently flexible to accommodate the introduction and implementation of innovative technologies as they evolve, and allow the further development and implementation of any proposed system in conformity with their provisions,

considering further

- a) that further technical, operational and regulatory studies are required in order to determine further the conditions under which sharing of the frequency bands 10 - 30 GHz which are allocated to the FSS and where Resolution 46 does not apply is feasible between GSO and non-GSO systems, between non-GSO systems and between non-GSO and terrestrial systems;
- b) that it is likely that non-GSO FSS systems communicated to the Radiocommunication Bureau will not be brought into use before the 1999 World Radiocommunication Conference (WRC-99);
- c) that the diverging interpretations arising from No. S22.2 result in an ambiguous regulatory status for both existing and future GSO and non-GSO systems in the fixed-satellite service (FSS) in the bands where this provision applies, with consequential risks for both types of systems;
- d) that the harmonious development of non-GSO and GSO systems in the FSS requires that these ambiguities be resolved with no further delay;
- e) that in resolving these ambiguities in the bands referred to in *resolves* 1 below, the GSO arc must be protected to ensure continued use of existing FSS systems and the development of new GSO technologies and systems in both unplanned bands and bands where plans exist;
- f) that these ambiguities may be resolved in certain frequency bands by adopting power flux-density (pfd) limits which would apply to non-GSO FSS systems to protect GSO FSS systems, and by including in Article S22 limits on the power radiated by non-GSO FSS systems in order adequately to protect GSO FSS systems in the frequency bands and sharing situations where Resolution 46 does not apply;
- g) that in certain frequency bands which are currently used or planned to be used extensively by GSO FSS systems, provisional power flux-density limits applicable to non-GSO FSS systems have been developed;
- h) that non-GSO FSS systems have been proposed in some of these bands which could meet these limits and would not require specific protection from existing and future GSO FSS systems, provided that minimum constraints are applied to GSO FSS systems, such as off-axis earth station e.i.r.p. limits;
- i) that in the bands where the limits referred to in *considering further* f), g) and h) would apply, there would be no need for a coordination procedure between non-GSO FSS and GSO systems, with the exception of coordination between earth stations operating in opposite directions of transmission;

- j) that there would be a need for a coordination procedure between non-GSO systems in the FSS and between non-GSO FSS systems and non-GSO systems in other services and for specific sharing criteria associated with this procedure, taking into consideration various types of non-GSO systems, including those in highly elliptical orbits;
- k) the need to protect other co-primary services having allocations in the frequency bands referred to in *considering further* a) above and the need to assess further the sharing conditions between non-GSO FSS systems and these services;
- l) that further studies on sharing conditions in frequency bands other than the 10 - 30 GHz frequency bands, where Resolution 46 does not apply, may also be necessary on the basis of the requirements that may emerge,

noting

- 1 that information relating to GSO and non-GSO systems in the FSS in the 10 - 30 GHz bands has been communicated to the Radiocommunication Bureau;
- 2 that some of these systems are in operation and others will be operated in the near future and, consequently, difficulties may be experienced in modifying their characteristics;
- 3 the need to protect existing and future terrestrial and space services and systems;
- 4 that No. S22.2 is an operational provision which is to be applied between administrations, and does not require any specific action or finding by the Bureau,

recognizing

that the geostationary-satellite orbit and its associated spectrum are a uniquely valuable resource and that equitable access to this resource needs to be protected for all countries in the world,

resolves

- 1 that, as of 22 November 1997, in the frequency bands specified in Tables S22-3 and S22-4, and in Tables 1 and 2 in Annex 1 to this Resolution, non-GSO FSS systems shall apply the procedures of Sections I and III of Article 11/Section I of Article S9, Nos. S9.17 and S9.17A and the procedures of Article 13/S11, and the non-GSO FSS systems for which complete notification information has been received by the Radiocommunication Bureau after 21 November 1997 shall be subject to the provisional power limits in Article S22 and in Annex 1 to this Resolution;
- 2 that these limits shall be applied provisionally until the end of WRC-99, and that non-GSO systems in the fixed-satellite service for which complete notification information has been received by the Radiocommunication Bureau after 21 November 1997 shall be subject to the power limits in Article S22, as revised, if appropriate, by WRC-99;
- 3 that, as of 22 November 1997, in applying No. S22.2, administrations may consider these provisional power limits as corresponding to permissible levels of interference from a non-GSO system into a GSO system, irrespective of the dates of receipt by the Bureau of the complete notification information relating for the non-GSO system and of the complete coordination information for the GSO network;

4 that, as of the end of WRC-99, an administration operating a non-GSO FSS system which is in compliance with the limits in Article S22, as revised, if appropriate, by WRC-99, shall be considered as having fulfilled its obligations under No. S22.2 with respect to any GSO network, irrespective of the dates of receipt by the Bureau of the complete notification information for the non-GSO system and of the complete coordination information for the GSO network;

5 that, as of the end of WRC-99, in the frequency bands specified in No. S22.29 and Section 2.4 of Annex 1 to this Resolution, GSO FSS systems for which complete coordination information has been received by the Bureau after the end of WRC-99 shall be subject to the limits in Article S22 and in Sections 2.1, 2.2 and 2.3 of Annex 1 to this Resolution, as revised, if appropriate, by WRC-99;

6 that, as of 22 November 1997, in the frequency bands specified in No. S22.29 and Tables 1 and 2 of Annex 1 to this Resolution, non-GSO systems shall not claim protection from GSO networks operating in accordance with the Radio Regulations, irrespective of the dates of receipt by the Bureau of the complete notification information for the non-GSO FSS systems and of the complete coordination information for the GSO networks;

6bis that, between 22 November 1997 and the end of WRC-99, if an administration operating or bringing into use a GSO FSS system before the end of WRC-99 considers that a non-GSO FSS system proposed by another administration might cause unacceptable interference into its GSO system, then:

6bis.1 the administration operating the GSO system shall send to the administration operating the non-GSO FSS system, the technical details upon which its disagreement is based,

6bis.2 in the bands from 10.7 to 14.5 GHz, the administration operating the non-GSO FSS system shall resolve the difficulties,

6bis.3 in the frequency bands 17.8 - 18.6 GHz (space-to-Earth), 19.7 - 20.2 GHz (space-to-Earth), 27.5 - 28.6 GHz (Earth-to-space) and 29.5 - 30.0 GHz (Earth-to-space), the administrations concerned shall make every possible effort to resolve the difficulties by means of mutually acceptable adjustments to their networks;

7 that, if an administration bringing into use a GSO FSS system after the end of WRC-99 considers that a non-GSO FSS system proposed by another administration and which complies with the limits in Article S22, as revised, if appropriate, by WRC-99, might cause unacceptable interference into its GSO system, the administrations concerned shall make every possible effort to resolve the difficulties by means of mutually acceptable adjustments to their networks;

8 that, as of 22 November 1997, non-GSO systems in the FSS in the frequency bands referred to in *resolves* 1 above, shall, for coordination with other non-GSO FSS systems, be subject to application of the provisions of § 2.1 of Section II of Resolution 46 (WRC-97)/No. S9.12,

requests ITU-R

- 1¹ taking into account *considering further a*), to conduct, as a matter of urgency, and complete, in time for consideration by WRC-99:
- a) the appropriate technical, operational and regulatory studies to review the regulatory conditions relating to the coexistence of non-GSO and GSO systems in the FSS, in order to ensure that they do not pose undue constraints on the development of non-GSO and GSO FSS systems;
 - b) the development of a methodology for calculating the power levels produced by non-GSO FSS systems and the compliance of these levels with the limits referred to in *resolves* 1 and 2 above;
 - c) the studies relating to the sharing criteria to be applied for determining the need for coordination between non-GSO FSS systems on the one hand and non-GSO systems in the FSS and in other space services and terrestrial services on the other hand, with a view to promoting efficient use of spectrum/orbit resources and equitable access to these resources by all countries;
- 2¹ taking into account *considering further 1*), to undertake the development of power limits or other frequency sharing mechanisms among GSO, non-GSO and terrestrial systems in the frequency bands other than those referred to in *resolves* 1 above and where non-GSO FSS systems are likely to be implemented and GSO systems are used or expected to be used extensively,

instructs the Radiocommunication Bureau

as of the end of WRC-99, to review and, if appropriate, revise, any finding previously made on the compliance with the limits contained in Article S22 of a non-GSO FSS system for which notification information has been received between 22 November 1997 and the end of WRC-99. This review shall be based on the values in Article S22, as revised, if appropriate, by WRC-99.

¹ See Annex 2 for further details concerning specific aspects of these studies in relation to frequency sharing between non-GSO FSS and GSO FSS.

ANNEX 1 TO RESOLUTION COM5-18 (WRC-97)

PROVISIONAL LIMITS

Section I. Control of Interference to Geostationary-Satellite Systems

1.1 The equivalent power flux-density¹, at any point on the Earth's surface visible from the geostationary-satellite orbit, produced by emissions from all the space stations of a non-geostationary-satellite system operating in the fixed-satellite service in the frequency bands listed in Table 1, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table 1 for the given percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions into all the reference antennas and in the reference bandwidths specified in Table 1, and for all pointing directions towards the geostationary-satellite orbit.

¹ The equivalent power flux-density is defined as the sum of the power flux-densities produced at a point of the Earth's surface by all space stations within a non-geostationary-satellite system, taking into account the off-axis discrimination of a reference receiving antenna assumed to be pointing towards the geostationary-satellite orbit. The equivalent power flux-density is calculated using the following formula:

$$epfd = 10 \cdot \log_{10} \left[\sum_{i=1}^{N_s} 10^{pfd_i/10} \cdot \frac{G_r(\theta_i)}{G_{max}} \right]$$

where:

- N_s is the number of non-geostationary space stations visible from the point considered at the Earth's surface, within an elevation angle greater than or equal to 0° ;
- i is the index of the non-geostationary space station considered;
- pfd_i is the power flux-density produced at the point considered at the Earth's surface in dB(W/m²) in the reference bandwidth;
- θ_i is the angle between the direction considered towards the geostationary-satellite orbit and the direction of the interfering space station in the non-geostationary-satellite system;
- $G_r(\theta_i)$ is the gain (as a ratio) of the receive reference antenna to be considered as part of a geostationary-satellite network;
- G_{max} is the maximum gain (as a ratio) of the above receive reference antenna;
- $epfd$ is the computed equivalent power flux-density in dB(W/m²) in the reference bandwidth.

NOTE - Table 1 contains provisional limits corresponding to an interference level caused by one non-GSO FSS system in the frequency bands to be applied in accordance with Resolution COM5-18. These provisional limits are subject to review by ITU-R and are subject to confirmation by WRC-99.

TABLE 1 (PART A)

Frequency band	Equivalent pfd dB(W/m ²)	Percentage of time during which epfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter and reference radiation pattern
10.7 - 11.7 GHz,	-179	99.7	4	60 cm, ITU-R Rec. 465-5
11.7 - 12.2 GHz	-192	99.9	4	3 m, ITU-R Rec. 465-5
in Region 2,	-186	99.97	4	3 m, ITU-R Rec. 465-5
12.2 - 12.5 GHz	-195	99.97	4	10 m, ITU-R Rec. 465-5
in Region 3 and	-170	99.999	4	60 cm, ITU-R Rec. 465-5
12.5 - 12.75 GHz	-173	99.999	4	3m, ITU-R Rec. 465-5
in Regions 1	-178	99.999	4	10 m, ITU-R Rec. 465-5
and 3	-170	100	4	≥60 cm, ITU-R Rec. 465-5

TABLE 1 (PART B)

Frequency band	Equivalent pfd dB(W/m ²)	Percentage of time during which epfd level may not be exceeded	Reference bandwidth (kHz)	Reference antenna diameter, and reference radiation pattern
17.8 - 18.6 GHz	-165	99.0	40	30 cm, ITU-R Rec. 465-5
	-151		1000	
	-165	99.0	40	70 cm, ITU-R Rec. 465-5
	-151		1000	
	-165	99.5	40	90 cm, ITU-R Rec. 465-5
	-151		1000	
	-167	99.8	40	1.5 m, ITU-R Rec. 465-5
	-153		1000	
	-180	99.9	40	5 m, ITU-R Rec. 465-5
	-166		1000	
	-184	99.9	40	7.5 m, ITU-R Rec. 465-5
	-170		1000	
	-188	99.9	40	12 m, ITU-R Rec. 465-5
	-174		1000	
	-165	100	40	30 cm to 12 m,
	-151		1000	

19.7 - 20.2 GHz	-154	99.0	40	30 cm, ITU-R Rec. 465-5
	-140		1000	
	-164	99.9	40	90 cm, ITU-R Rec. 465-5
	-150		1000	
	-167	99.8	40	2 m, ITU-R Rec. 465-5
	-153		1000	
	-174	99.9	40	5 m, ITU-R Rec. 465-5
	-160		1000	
	-154	100	40	30 cm to 12 m,
	-140		1000	ITU-R Rec. 465-5

1.2 The aggregate power flux-density² produced at any point in the geostationary-satellite orbit by the emissions from all the earth stations in a non-geostationary-satellite system operating in the fixed-satellite service, for all conditions and for all methods of modulation, shall not exceed the limits given in Table 2 for any percentage of time. These limits relate to the power flux-density which would be obtained under free-space propagation conditions in the reference bandwidth specified in Table 2.

² The aggregate power flux-density is defined as the summation of the power flux-densities produced at a point in the geostationary-satellite orbit by all the earth stations of a non-geostationary-satellite system. The aggregate power flux-density is computed by means of the following formula:

$$apfd = 10 \cdot \log_{10} \left[\sum_{i=1}^{N_e} 10^{P_i/10} \cdot \frac{G_i(\theta_i)}{4 \cdot \pi \cdot d_i^2} \right]$$

where:

- N_e is the number of earth stations in the non-geostationary-satellite system with an elevation angle greater than or equal to 0°, from which the point considered in the geostationary-satellite orbit is visible;
- i is the index of the earth station considered in the non-geostationary-satellite system;
- P_i is the RF power at the input of the transmitting antenna of the earth station considered in the non-geostationary-satellite system in dBW in the reference bandwidth;
- θ_i is the off-axis angle between the boresight of the earth station considered in the non-geostationary-satellite system and the direction of the point considered in the geostationary-satellite orbit;
- $G_i(\theta_i)$ is the transmit antenna gain (as a ratio) of the earth station considered in the non-geostationary system in the direction of the point considered in the geostationary-satellite orbit;
- d_i is the distance in metres between the earth station considered in the non-geostationary-satellite system and the point considered in the geostationary-satellite orbit;
- $apfd$ is the aggregate power flux-density in dB(W/m²) in the reference bandwidth.

NOTE - Table 2 contains provisional limits corresponding to an interference level caused by one non-GSO FSS system in the frequency bands to be applied in accordance with Resolution COM5-18. These provisional limits are subject to review by ITU-R and are subject to confirmation by WRC-99.

TABLE 2 (PART A)

Frequency band	Aggregate pfd dB(W/m ²)	Percentage of time during which apfd level may not be exceeded	Reference bandwidth (kHz)
12.5 - 12.75 GHz,	-170	100	4
12.75 - 13.25 GHz	-186	100	4
and	-170	100	4
13.75 - 14.5 GHz			

TABLE 2 (PART B)

Frequency band	Aggregate pfd dB(W/m ²)	Percentage of time during which apfd level may not be exceeded	Reference bandwidth (kHz)
27.5 - 28.6 GHz and	-159	100	40
29.5 - 30 GHz	-145	100	1000

1.3 The limits given in Table 1 may be exceeded on the territory of any country whose administration has so agreed.

Section II. Earth Station Off-Axis Power Limitations in the Fixed-Satellite Service¹

2.1 The level of equivalent isotropically radiated power (e.i.r.p.) emitted by an earth station shall not exceed the following values for any off-axis angle ϕ which is 2.5° or more off the main lobe axis of an earth station antenna:

¹ The provisions of this section are suspended pending the review of the values in §§ 2.1, 2.2 and 2.3 by WRC-99.

<i>Off-axis angle</i>	<i>Maximum e.i.r.p. per 40 kHz</i>
$2.5^\circ \leq \varphi \leq 7^\circ$	$(39 - 25 \log \varphi) \text{ dB(W/40 kHz)}$
$7^\circ < \varphi \leq 9.2^\circ$	18 dB(W/40 kHz)
$9.2^\circ < \varphi \leq 48^\circ$	$(42 - 25 \log \varphi) \text{ dB(W/40 kHz)}$
$48^\circ < \varphi \leq 180^\circ$	0 dB(W/40 kHz)

2.2 For FM-TV emissions with energy dispersal, the limits in § 2.1 above may be exceeded by up to 3 dB provided that the off-axis total e.i.r.p. of the transmitted FM-TV carrier does not exceed the following values:

<i>Off-axis angle</i>	<i>Maximum e.i.r.p.</i>
$2.5^\circ \leq \varphi \leq 7^\circ$	$(53 - 25 \log \varphi) \text{ dBW}$
$7^\circ < \varphi \leq 9.2^\circ$	32 dBW
$9.2^\circ < \varphi \leq 48^\circ$	$(56 - 25 \log \varphi) \text{ dBW}$
$48^\circ < \varphi \leq 180^\circ$	14 dBW

2.3 FM-TV carriers which operate without energy dispersal should be modulated at all times with programme material or appropriate test patterns. In this case, the off-axis total e.i.r.p. of the emitted FM-TV carrier shall not exceed the following values:

<i>Off-axis angle</i>	<i>Maximum e.i.r.p.</i>
$2.5^\circ \leq \varphi \leq 7^\circ$	$(53 - 25 \log \varphi) \text{ dBW}$
$7^\circ < \varphi \leq 9.2^\circ$	32 dBW
$9.2^\circ < \varphi \leq 48^\circ$	$(56 - 25 \log \varphi) \text{ dBW}$
$48^\circ < \varphi \leq 180^\circ$	14 dBW

2.4 The e.i.r.p. limits given in §§ 2.1, 2.2 and 2.3 are applicable in the following frequency bands allocated to the fixed-satellite service (Earth-to-space):

12.75 - 13.25 GHz
 13.75 - 14 GHz
 14 - 14.5 GHz

ANNEX 2 TO RESOLUTION COM5-18 (WRC-97)

ITU-R STUDIES ON FREQUENCY SHARING BETWEEN NON-GSO FSS AND GSO FSS

The following is a list of the studies and related activities required.

- 1) Characterization of short-duration interference peaks which might exceed epfd limits set by a WRC for large earth station antennas, in terms of maximum and mean amplitudes, maximum and mean durations, mean time between occurrences, aggregate percentages of time of occurrences and typical amplitude/time profiles.
- 2) Acquisition of data relating to the impact of the interference peaks on the performance of a range of earth station demodulators of various types and origins. Administrations are encouraged to cooperate in this matter by arranging for the appropriate measurements to be carried out, and submitting the results to the appropriate working parties or task groups in time to be included in the ITU-R report to the next conference.
- 3) Carrying out computer simulations to determine the impact on epfd statistics of multiple non-GSO networks interfering with a GSO downlink, and in particular to discover the percentage-of-time thresholds for which the probability of simultaneous interference peaks from satellites in different non-GSO constellations becomes significant. Both homogeneous and inhomogeneous sets of non-GSO systems should be simulated where the necessary data are available.
- 4) Conducting investigations to find out whether the emissions from the satellites and earth stations of non-GSO systems would cause problems for the TT&C of GSO (and non-GSO) satellites, during both their launch and operational phases, and the development of methods for avoiding such problems.
- 5) Carrying out computer simulations to derive the time statistics of short-term interference between two or more non-GSO FSS networks, with the objective of determining the approximate number of such networks which could co-exist in the same bands.
- 6) Identification and validation of software which could be used by BR to check whether a system for which an application for spectrum has been made would comply with the epfd and apfd limits.
- 7) Carrying out studies to determine the feasibility of frequency sharing between non-GSO FSS networks using circular orbits and networks using slightly-inclined geostationary orbits, and also between non-GSO FSS networks and networks using "quasi-geostationary" orbits.
- 8) Development, if practicable, of continuous curves of epfd versus antenna diameter and/or G/T of the GSO earth station to be protected. Whilst it may be necessary to limit the compliance checking by BR to a few discrete antenna sizes, administrations will need to know that the protection will be adequate in the cases of antennas of other sizes; hence the desirability of continuous curves.

- 9) Continuation of studies on techniques for the mitigation of interference between GSO and non-GSO networks, and between non-GSO and non-GSO networks.
- 10) Refinement of the methodologies in new Recommendation ITU-R [Document BL/14] for the derivation of I/N limits and their conversion to epfd and apfd limits, taking into account propagation fade statistics, the different circumstances of "transparent" and remodulating satellite transponders, and the impact of fade counter-measures such as adaptive power control.
- 11) Consideration of how account can be taken, in studies concerning the definition of uplink limits, of the gain versus off-axis angle characteristics of the receiving spot beams of geostationary satellites.
- 12) Taking into account that the bands allocated to the FSS are used by the fixed, radiolocation and space science services, study of the criteria for sharing between non-GSO FSS and GSO FSS systems and systems in those services.

RESOLUTION COM5-19 (WRC-97)
USE OF THE FREQUENCY BANDS COVERED BY
APPENDICES 30 AND 30A BY NON-GSO SYSTEMS IN THE
FIXED-SATELLITE SERVICE

The World Radiocommunication Conference (Geneva, 1997),

considering

- a) that provisional limits have been established and included in Article S22 and in the Annex to this Resolution to ensure that the interference caused by non-geostationary-satellite (non-GSO) systems in the fixed-satellite service (FSS) into assignments operated in conformity with the Appendices 30 and 30A Plans is maintained within negligible levels;
- b) that the integrity of the above-mentioned Plans and their future modifications is to be ensured;
- c) that non-GSO systems should not be entered into those Plans and therefore should not apply the procedures associated with the Plans and should not be protected by those procedures;
- d) that this Conference has decided to introduce in Article S5 of the Radio Regulations a new allocation to the FSS in the frequency bands 11.7 - 12.5 GHz in Region 1, 12.2 - 12.7 GHz in Region 2 and 11.7 - 12.2 GHz in Region 3, limited to non-GSO FSS systems,

resolves

- 1 that, as of 22 November 1997:
 - a) a non-GSO FSS system operating in the frequency bands covered by Appendices 30 and 30A shall comply with the provisional limits specified in Article S22 and in the Annex to this Resolution;
 - b) such a system shall, as of the end of WRC-99, comply with the limits specified in Article S22, as revised, if appropriate, by WRC-99, irrespective of the date of receipt of the complete notification information relating to the non-GSO FSS system;
 - c) as of 22 November 1997, in applying No. S22.2, administrations may consider these provisional power limits as corresponding to permissible levels of interference from a non-GSO system into a GSO system, irrespective of the dates of receipt by the Bureau of the complete notification information for the non-GSO system and for the GSO network;
 - d) as of the end of WRC-99, an administration operating a non-GSO FSS system in the band 17.8 - 18.1 GHz (space-to-Earth) which is in compliance with the limits appearing in Article S22 as revised, if appropriate, by WRC-99, shall be considered as having fulfilled its obligations under No. S22.2 with respect to any GSO network operating in the Earth-to-space direction, irrespective of the dates of receipt by the Bureau of the complete notification information for the non-GSO system and of the complete coordination or notification information, as appropriate, for the GSO network;

- d1) between 22 November 1997 and the end of WRC-99, if an administration operating or bringing into use a GSO system before the end of WRC-99 considers that a non-GSO FSS system proposed by another administration might cause unacceptable interference into its GSO system, then:
- the administration operating the GSO system shall send to the administration operating the non-GSO FSS system, the technical details upon which its disagreement is based;
 - the administration operating the non-GSO FSS system shall resolve the difficulties, taking into account especially degradation of picture and sound quality or signal availability with regard to GSO systems in operation;
- e) a non-GSO FSS system operating in the frequency bands covered by Appendices 30 and 30A shall apply the procedures of Sections I and III of Article 11/Section I of Article S9, and S9.17 and S9.17A, and the procedures of Article 13/S11;
- f) such a system shall be subject, for the coordination with non-GSO systems, to the application of the provisions of § 2.1 of Section II of Resolution 46 (WRC-97)/No. S9.12;
- g) such a system shall apply, using an equivalent power flux-density threshold of $-185.3 \text{ dB(W/m}^2/4 \text{ kHz)}$ for 99.7% of the time, calculated with the reference 90 cm diameter antenna pattern provided in Annex 5 of Appendix 30 (Orb-85) for Regions 1 and 3, the provisions of Article 7 of Appendix 30/S9.8 with respect to assignments which appear in Article 11 of Appendix S30 or in Article 9A of Appendix S30A with the symbols AE or PE;
- 2 that non-GSO FSS systems in the frequency bands referred to in *resolves* 1 above shall not be operated before the end of WRC-99,

requests ITU-R

- a) to conduct, as a matter of urgency and in time for consideration by WRC-99, the appropriate technical, operational and regulatory studies to review the regulatory provisions concerning the operation of non-GSO FSS systems in the frequency bands referred to in *resolves* 1 a) above in order to ensure that these conditions ensure appropriate protection of the Plans and their future modifications and do not place unreasonable constraints on the development of GSO systems in these bands;
- b) to undertake and complete the development of a methodology for calculating the power levels produced by non-GSO FSS systems and the compliance of these levels with the limits referred to in *resolves* 1 a) and 1 b) above;
- c) to complete the studies relating to the sharing criteria to be applied for determining the need for coordination between non-GSO FSS systems, with a view to promoting efficient use of spectrum/orbit resources and equitable access to these resources by all countries;
- d) to report to CPM-99 on the conclusion of these studies,

instructs the Radiocommunication Bureau

as of the end of WRC-99, to review and, if appropriate, revise, any finding previously made on the compliance with the limits contained in Article S22 of a non-GSO FSS system for which notification information has been received between 22 November 1997 and the end of WRC-99. This review shall be based on the values in Article S22, as revised, if appropriate, by WRC-99.

ANNEX TO RESOLUTION COM5-19 (WRC-97)

PROVISIONAL LIMITS

Section I. Control of Interference to Geostationary-Satellite Systems

1.1 In the frequency band 17.8 - 18.1 GHz, the maximum aggregate power flux-density produced at the geostationary-satellite orbit by all the space stations in a non-geostationary-satellite system in the fixed-satellite service shall not exceed the values given in Table 2.

1.2 The equivalent power flux-density¹, at any point on the Earth's surface visible from the geostationary-satellite orbit, produced by emissions from all the space stations of a non-geostationary-satellite system operating in the fixed-satellite service in the frequency bands listed in Table 1, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the limits given in Table 1 for the given percentages of time. These limits relate to the equivalent power flux-density which would be obtained under free-space propagation conditions, into a reference antenna and in the reference bandwidth as specified in Table 1, for all pointing directions towards the geostationary-satellite orbit.

¹ The equivalent power flux-density is defined as the sum of the power flux-densities produced at a point of the Earth's surface by all space stations within a non-geostationary-satellite system, taking into account the off-axis discrimination of a reference receiving antenna assumed to be pointing towards the geostationary-satellite orbit. The equivalent power flux-density is calculated using the following formula:

$$epfd = 10 \cdot \log_{10} \left[\sum_{i=1}^{N_s} 10^{pfd_i/10} \cdot \frac{G_r(\theta_i)}{G_{max}} \right]$$

where:

- N_s is the number of non-geostationary space stations visible from the point considered at the Earth's surface, within an elevation angle greater than or equal to 0° ;
- i is the index of the non-geostationary space station considered;
- pfd_i is the power flux-density produced at the point considered at the Earth's surface in dB(W/m²) in the reference bandwidth;
- θ_i is the angle between the direction considered towards the geostationary-satellite orbit and the direction of the interfering space station in the non-geostationary system;
- $G_r(\theta_i)$ is the gain (as a ratio) of the receive reference antenna to be considered as part of a geostationary-satellite network;
- G_{max} is the maximum gain (as a ratio) of the above receive reference antenna;

– *epfd* is the computed equivalent power flux-density in dB(W/m²) in the reference bandwidth.

NOTE - Table 1 contains provisional limits corresponding to an interference level caused by one non-GSO FSS system in the frequency bands to be applied in accordance with Resolution COM5-18. These provisional limits are subject to review by ITU-R and are subject to confirmation by WRC-99.

TABLE 1

Frequency band allocated to the BSS	Antenna diameter (cm)	Equivalent pfd level (dB(W/m ² / 4 kHz)) which may not be exceeded during the percentage of time shown		Reference antenna radiation pattern
		99.7%	100%	
11.7 - 12.5 GHz in Region 1, 11.7 - 12.2 GHz and 12.5 - 12.75 GHz in Region 3	30 60 90	-172.3 -183.3 -186.8	-169.3 -170.3 -170.3	Recommendation ITU-R BO.1213
12.2 - 12.7 GHz in Region 2	45 100 120 180	-174.3 -186.3 -187.9 -191.4	-165.3 -170.3 -170.3 -170.3	Section 3.7.2 of Annex 5 of Appendix 30
17.3 - 17.8 GHz in Region 2	For further study ¹⁾			
¹⁾ The interference from non-GSO FSS systems into GSO BSS systems operating in the frequency bands 17.3 - 17.8 GHz relates to the two following sharing situations: <ul style="list-style-type: none">• non-GSO FSS transmit earth station into GSO receive earth station;• GSO BSS transmit space station into non-GSO FSS receive space stations. Both situations need to be studied, in particular since coexistence of receive BSS earth stations and large numbers of transmit non-GSO FSS terminals would not be feasible within the same country.				

1.3 The aggregate power flux-density² produced at any point in the geostationary-satellite orbit by the emissions from all the earth stations in a non-geostationary system in the fixed-satellite service, for all conditions and for all methods of modulation, shall not exceed the limits given in Table 2 for the specified percentages of time. These limits relate to the power flux-density which would be obtained under free-space propagation conditions in the reference bandwidth specified in Table 2.

² The aggregate power flux-density is defined as the summation of the power flux-densities produced at a point in the geostationary-satellite orbit by all the earth stations of a non-geostationary-satellite system. The aggregate power flux-density is computed by means of the following formula:

$$apfd = 10 \cdot \log_{10} \left[\sum_{i=1}^{N_e} 10^{P_i/10} \cdot \frac{G_i(\theta_i)}{4 \cdot \pi \cdot d_i^2} \right]$$

where:

- N_e is the number of earth stations in the non-geostationary-satellite system with an elevation angle greater than or equal to 0° , from which the point considered in the geostationary-satellite orbit is visible;
- i is the index of the earth station considered in the non-geostationary-satellite system;
- P_i is the RF power at the input of the transmitting antenna of the earth station considered in the non-geostationary-satellite system in dBW in the reference bandwidth;
- θ_i is the off-axis angle between the boresight of the earth station considered in the non-geostationary-satellite system and the direction of the point considered in the geostationary-satellite orbit;
- $G_i(\theta_i)$ is the transmit antenna gain (as a ratio) of the earth station considered in the non-geostationary-satellite system in the direction of the point considered in the geostationary-satellite orbit;
- d_i is the distance in metres between the earth station considered in the non-geostationary-satellite system and the point considered in the geostationary-satellite orbit;
- $apfd$ is the aggregate power flux-density in dB(W/m²) in the reference bandwidth.

NOTE - Table 2 contains provisional limits corresponding to an interference level caused by one non-GSO FSS system in the frequency bands to be applied in accordance with Resolution COM5-18. These provisional limits are subject to review by ITU-R and are subject to confirmation by WRC-99.

TABLE 2

Frequency band	Aggregate pfd dB(W/m ² /4 kHz)	Percentage of time during which apfd level may not be exceeded
17.3 - 18.1 GHz in Regions 1 and 3 and 17.8 - 18.1 GHz in Region 2	-163	100%

1.4 The limits given in Table 1 may be exceeded on the territory of any country whose administration has so agreed.

RES COM5-20, RES COM5-21, RES COM5-22 (Not used)

RESOLUTION COM5-23 (WRC-97)

**POWER FLUX-DENSITY LIMITS APPLICABLE TO NON-GSO FSS SYSTEMS
FOR PROTECTION OF TERRESTRIAL SERVICES IN THE BANDS
10.7 - 12.75 GHz AND 17.7 - 19.3 GHz**

The World Radiocommunication Conference (Geneva, 1997),

considering

- a) that the power flux-density (pfd) limits specified in Table S21-4 for the bands 10.7 - 12.75 GHz and 17.7 - 19.7 GHz for the protection of terrestrial services were originally developed assuming that potentially interfering space stations in the fixed-satellite service (FSS) would operate in the geostationary-satellite orbit (GSO);
- b) that the results of studies to date on potential interference from non-GSO FSS networks in the 18.8 - 19.3 GHz range, but which may be extrapolated to the 17.7 - 19.3 GHz range, differ as to whether the power flux-density limits in Article S21 would provide adequate protection of the fixed service when applied to non-GSO networks with a large number of satellites (i.e. greater than 100);
- c) that, in the 10.7 - 12.75 GHz band, some initial sharing studies have been undertaken and further work is required in order to assess the adequacy of the existing power flux-density limits;
- d) that further studies are required of the power flux-density limits applicable to non-GSO FSS systems for the protection of terrestrial services in the bands 10.7 - 12.75 GHz and 17.7 - 19.3 GHz,

noting

- a) that the former Resolution 118 (WRC-95) requested studies of the criteria for sharing between non-GSO FSS systems and terrestrial services in the 20/30 GHz bands;
- b) that non-GSO FSS networks are being developed that take into account the power flux-density limits that were in force prior to this Conference; however, in the band 18.8 - 19.3 GHz, these values were subject to review by ITU-R;
- c) that modifications to existing FSS network design or operating parameters may be needed in order to obtain conformance with the revised limits adopted by this Conference;
- d) that the band 18.6 - 18.8 GHz is allocated to the earth exploration-satellite (passive) and space research (passive) services and that administrations should endeavour to reduce to a minimum the risks of interference to passive sensors; the interference criteria for satellite passive sensors are contained in Recommendation ITU-R SA.1029,

resolves

1 that emissions from a space station in non-GSO FSS networks in the bands 10.7 - 12.75 GHz and 17.7 - 19.3 GHz shall comply with the power flux-density limits contained in Article S21 and in Annex 1 to this Resolution for the protection of terrestrial services (see *considering d*));

2 that in view of *noting b*) in relation to the 18.8 - 19.3 GHz band in the case of non-GSO FSS networks for which complete coordination or notification information has been received by the Radiocommunication Bureau by 17 November 1995, or are in operation by that date, the power flux-density limits which were in force prior to 27 October 1997 shall continue to apply; in the case of non-GSO FSS networks for which such information was received after 17 November 1995, the power flux-density limits in Annex 1 to this Resolution will apply,

invites ITU-R

to study, as a matter of urgency, the appropriate power flux-density values to be applied to non-GSO networks in the aforementioned bands to ensure protection of the fixed service without unduly constraining the development of either type of network,

requests WRC-99

to review the provisional limits referred to in *resolves 1* based on the results of the studies carried out by ITU-R,

urges administrations

to consider reductions in the power flux-density or the number of satellites in non-GSO FSS networks within the spirit of No. S9.58, so as to facilitate sharing between non-GSO FSS networks and systems in the fixed service.

ANNEX 1

Frequency band	Service	Limits in dB(W/m ²) for angle of arrival δ above the horizontal plane			Reference bandwidth
		0° - 5°	5° - 25°	25° - 90°	
10.7 - 11.7 GHz	Fixed-satellite (S-E)	-150 ¹⁾	-150 + 0.5(δ -5) ¹⁾	-140 ¹⁾	4 kHz
12.2 - 12.5 GHz (R3) 12.5 - 12.75 GHz (R1 and R3 countries listed in Nos. S5.494 and S5.496)	Fixed-satellite (S-E)	-148 ¹⁾	-148 + 0.5(δ -5) ¹⁾	-138 ¹⁾	4 kHz
11.7 - 12.5 GHz (R1) 12.2 - 12.7 GHz (R2) 11.7 - 12.2 GHz (R3) 11.7 - 12.2 GHz (R2)	Fixed-satellite (S-E), non-GSO	-148 ²⁾	-148 + 0.5(δ -5) ²⁾	-138 ²⁾	4 kHz
17.7 - 19.3 GHz ^{3), 4)}	Fixed-satellite (S-E)	-115 or -125 ⁵⁾	-115 + 0.5 (δ -5) or -125 + (δ -5) ⁵⁾	-105 or -105 ⁵⁾	1 MHz

¹⁾ Although these limits apply to both GSO and non-GSO FSS satellites, values for non-GSO systems require further study.

²⁾ These values require further study.

³⁾ The equality of rights to operate when a frequency band is allocated in different Regions to different services of the same category is established in No. S4.8. Therefore, any limits concerning inter-Regional interference which may appear in ITU-R Recommendations should, as far as practicable, be observed by administrations.

⁴⁾ The band 18.6 - 18.8 GHz is allocated to the earth exploration-satellite (passive) and space research (passive) services. Administrations should endeavour to reduce to a minimum the risks of interference to passive sensors. The interference criteria for satellite passive sensors are contained in Recommendation ITU-R SA.1029.

⁵⁾ These values shall apply provisionally only to emissions of space stations on non-geostationary satellites in networks operating with a large number of satellites, that is systems operating with more than 100 satellites.

RESOLUTION COM5-24 (WRC-97)

**USE OF THE BANDS 1 525 - 1 559 MHz AND 1 626.5 - 1 660.5 MHz
BY THE MOBILE-SATELLITE SERVICE**

The World Radiocommunication Conference (Geneva, 1997),

considering

- a) that this Conference allocated the bands 1 525 - 1 559 MHz (space-to-Earth) and 1 626.5 - 1 660.5 MHz (Earth-to-space) to the mobile-satellite service (MSS) to facilitate the assignment of spectrum to multiple mobile-satellite systems in a flexible and efficient manner;
- b) that prior to this Conference there was a generic allocation by footnote provisions in some countries for the use of the bands 1 530 - 1 544 MHz and 1 631.5 - 1 645.5 MHz by the mobile-satellite service, on condition that maritime mobile-satellite distress and safety communications have priority access over all other communications;
- c) that prior to this Conference, there was a generic allocation by two footnotes for the use of the bands 1 555 - 1 559 MHz and 1 656.5 - 1 660.5 MHz by the mobile-satellite service, and in one of these footnotes the following conditions applied in two countries:
 - the aeronautical mobile-satellite (R) service has priority access and immediate availability over all other communications within a network;
 - mobile-satellite systems should be interoperable with the aeronautical mobile-satellite (R) service;
 - account shall be taken of the priority of safety-related communications in the other mobile-satellite services;
- d) that there is at least one global mobile-satellite system that is capable of providing global maritime mobile-satellite distress and safety communications according to Article S53 and global AMS(R)S communications with priorities 1 to 6 of Article S44 in accordance with IMO and ICAO requirements;
- e) that technical considerations for sharing satellite network resources between MSS (other than AMS(R)S) and AMS(R)S have been developed by ITU-R (see Recommendation ITU-R M.8/17);
- f) that global and regional mobile-satellite systems are being multilaterally coordinated in the bands 1 525 - 1 559 MHz (space-to-Earth) and 1 626.5 - 1 660.5 MHz (Earth-to-space) and that the ITU Radio Regulations provide the international framework for multilateral agreements;
- g) that in Nos. S5.362A and S5.353A priority has been given to accommodating the spectrum requirements for distress, urgency and safety communications of GMDSS and AMS(R)S communications with priorities 1 to 6 of Article S44 of AMS(R)S. See No. S9.11A, except No. S9.13,

further considering

- a) that the Convention on International Civil Aviation requires that stations of the AMS(R)S shall be in compliance with the internationally agreed Standards and Recommended Practices (SARP) and Procedures for Air Navigation Services (PANS);
- b) that ICAO has developed a global Air Traffic Management system (ATM) which requires interoperability between stations operating in accordance with the ICAO Convention for those mobile-satellite systems providing AMS(R)S with the priority message structure of Article S44;
- c) that this Conference modified provisions for the operational use of the Global Maritime Distress and Safety System (GMDSS) which is fully defined in the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended (see No. MOD S30.1);
- d) that IMO may also place similar requirements of interoperability for those mobile-satellite systems providing GMDSS communications with the priority message structure of Article S53,

recognizing

that Appendix S15.2 identifies the bands 1 530 - 1 544 MHz (space-to-Earth) and 1 626.5 - 1 645.5 MHz (Earth-to-space) for distress and safety purposes in the maritime mobile-satellite service as well as for routine non-safety purposes,

noting

that some countries in Region 2 use the bands 1 525 - 1 544 MHz, 1 545 - 1 559 MHz, 1 626.5 - 1 645.5 MHz and 1 646.5 - 1 660.5 MHz to provide national MSS on a generic basis and, where agreements with other administrations concerned are in place, provide multinational service,

resolves

- 1 that the future spectrum requirements for the provision of distress, urgency and safety communications in the GMDSS by the mobile-satellite service and AMS(R)S communications with priority 1 to 6 of Article S44 should take into account internationally agreed assumptions and methodologies and information on actual GMDSS and AMS(R)S communication traffic usage and growth;
- 2 that the feasibility of prioritization, real-time pre-emptive access and, if necessary, interoperability between different mobile-satellite systems for GMDSS and AMS(R)S should be determined, in order to achieve the most flexible and practical use of the generic allocations,

requests ITU-R

- 1 to develop assumptions and methodologies and gather information on actual GMDSS and AMS(R)S communication traffic usage and growth, in order to determine the future spectrum requirements for the provision of distress, urgency and safety communications in the GMDSS by the mobile-satellite service and AMS(R)S communications with priority 1 to 6 of Article S44;
- 2 to determine the feasibility of prioritization, real-time pre-emptive access and, if necessary, interoperability between different mobile-satellite systems for GMDSS and AMS(R)S, in order to achieve the most flexible and practical use of the generic allocations;
- 3 to complete and report the results of the studies called for in *requests ITU-R* 1 and 2 above by WRC-99 or a future competent conference,

requests the next competent WRC

to take into account the outcome of ITU-R studies and take appropriate action on this subject,

invites

ICAO, IMO, IALA, administrations and other organizations concerned to participate in the studies identified in *requests ITU-R* 1 and 2 above.

RESOLUTION COM5-25 (WRC-97)

**STUDIES RELATING TO CONSIDERATION OF THE ALLOCATION TO THE
NON-GEOSTATIONARY MOBILE-SATELLITE SERVICE (MSS) IN THE
METEOROLOGICAL AIDS BAND 405 - 406 MHz AND THE
IMPACT ON PRIMARY SERVICES ALLOCATED IN THE
ADJACENT BANDS**

The World Radiocommunication Conference (Geneva, 1997),

considering

- a) that there is a significant shortfall of spectrum for the non-geostationary orbit (non-GSO) MSS below 1 GHz, and there is an urgent need to make additional spectrum available on a worldwide basis for such non-GSO MSS systems;
- b) that the CPM-97 Report to WRC-97 states that the Radiocommunication Bureau (BR) has identified 23 non-GSO MSS networks, at frequencies below 1 GHz, at some state of coordination under (Resolution 46) S9.11A, that it is likely that a number of these systems may not be implemented for reasons not connected with spectrum availability and that several administrations have indicated in their information submitted to BR that they plan on implementing these non-GSO MSS systems by the year 2002 or earlier;
- c) that the CPM-97 Report for WRC-97 also states that it appears that many of the proposed networks cannot be implemented in the existing allocations because there is not enough spectrum to allow the development of all of these systems in an economically viable manner;
- d) that meteorological aids systems are essential to produce the upper air measurements required by the World Meteorological Organization (WMO), as summarized in Recommendation ITU-R SA.1165, and that systems using the band 400.15 - 406 MHz constitute the majority of the mobile and fixed observation stations worldwide;
- e) that meteorological aids systems are also essential to produce the upper air measurements required for civilian and other applications;
- f) that the amount of spectrum required by meteorological users, including WMO (station spacing requirement of 250 km), civilian users and other related users, in most geographical areas is about 5 MHz in the band 401 - 406 MHz using the currently employed technology;
- g) that since this Conference upgraded allocation to the earth exploration-satellite service and the meteorological-satellite service to primary in the band 401 - 403 MHz, this is likely to impose constraints on the meteorological aids service in this band in certain geographical areas;